GEOLOGIC CHARATCTERIZATION OF LAKE DIXIE

LAKE COUNTY, FLORIDA

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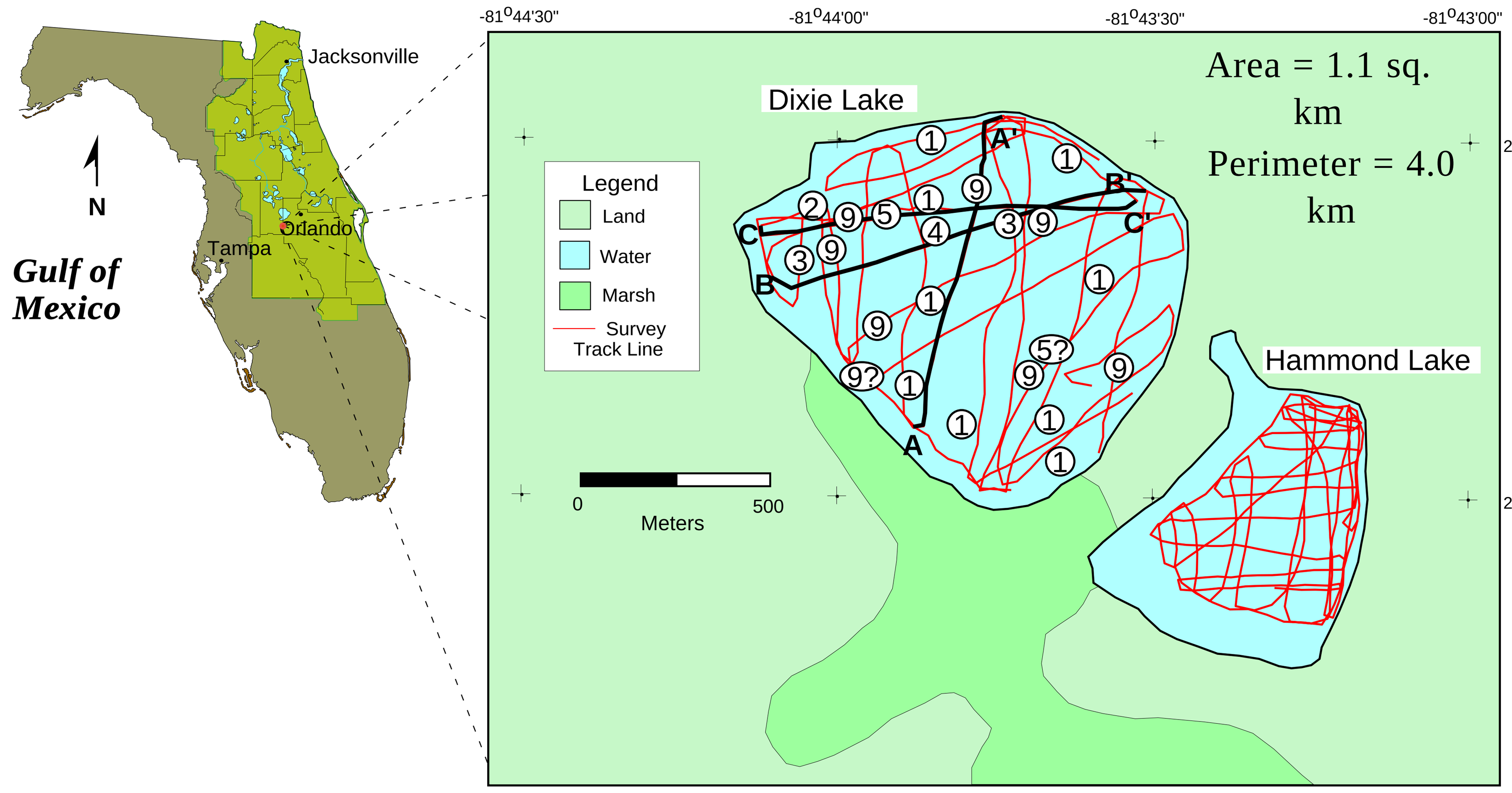
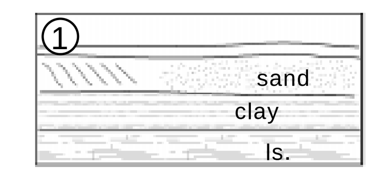
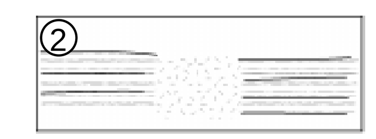


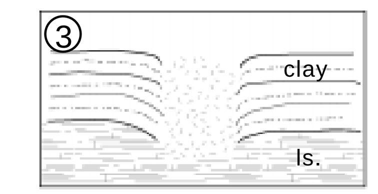
EXPLANATION



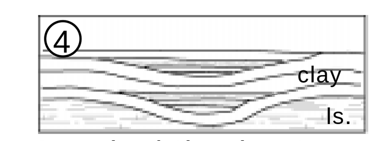
Undisturbed section, with or without upper non-reflective sand layer. Sand layer may show reflection where cross bedding from original deposition (fluvial or aeolian) exits. Clay layers are mostly intact.



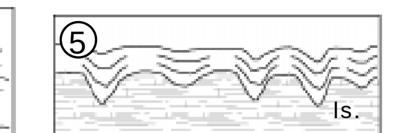
Undisturbed section with areas obscured by noise created by muck or aquatic vegetation dispersing the acoustic signal.



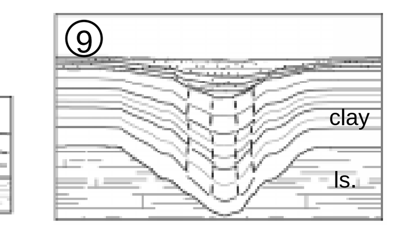
Horizontal reflectors continuous on either side of a central non-reflective zone. Horizontal layers bend downward towards the central zone. These features are representative of filled collapse sinks. The size may range from tens of meters to kilometers across a lake basin.



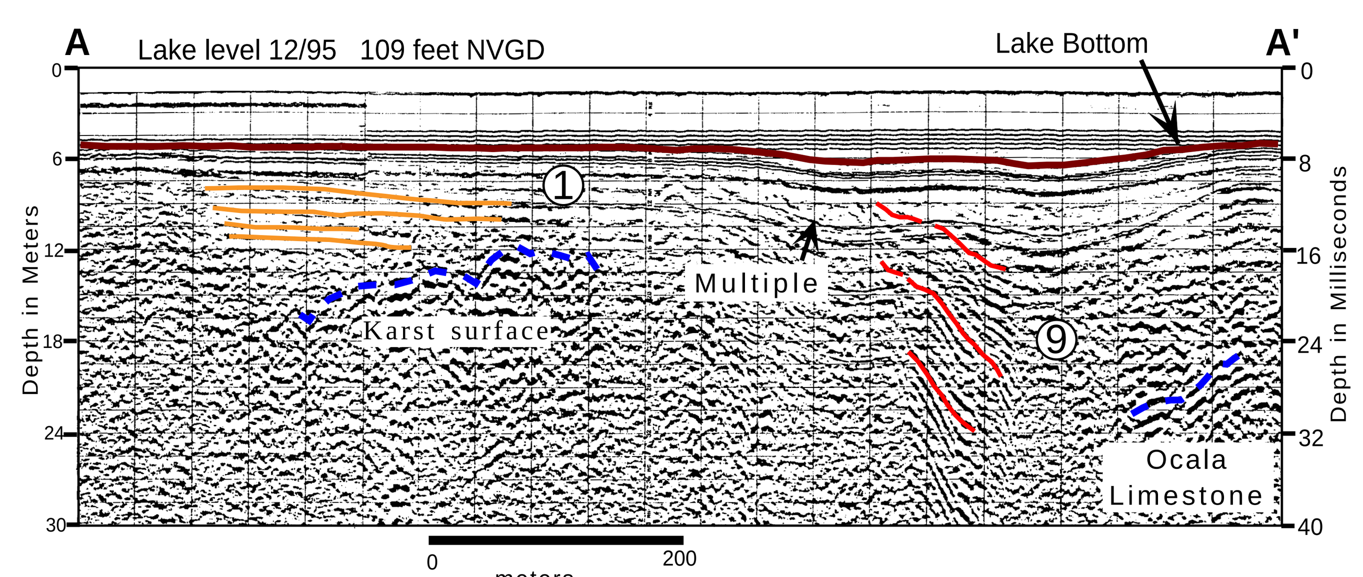
Low angle, subsidence depressions. Parallel reflectors are relatively intact. Horizontal reflectors onlap onto the subsided parallel reflectors and represent deposition during subsidence. These can be large basin size features or tens of feet.

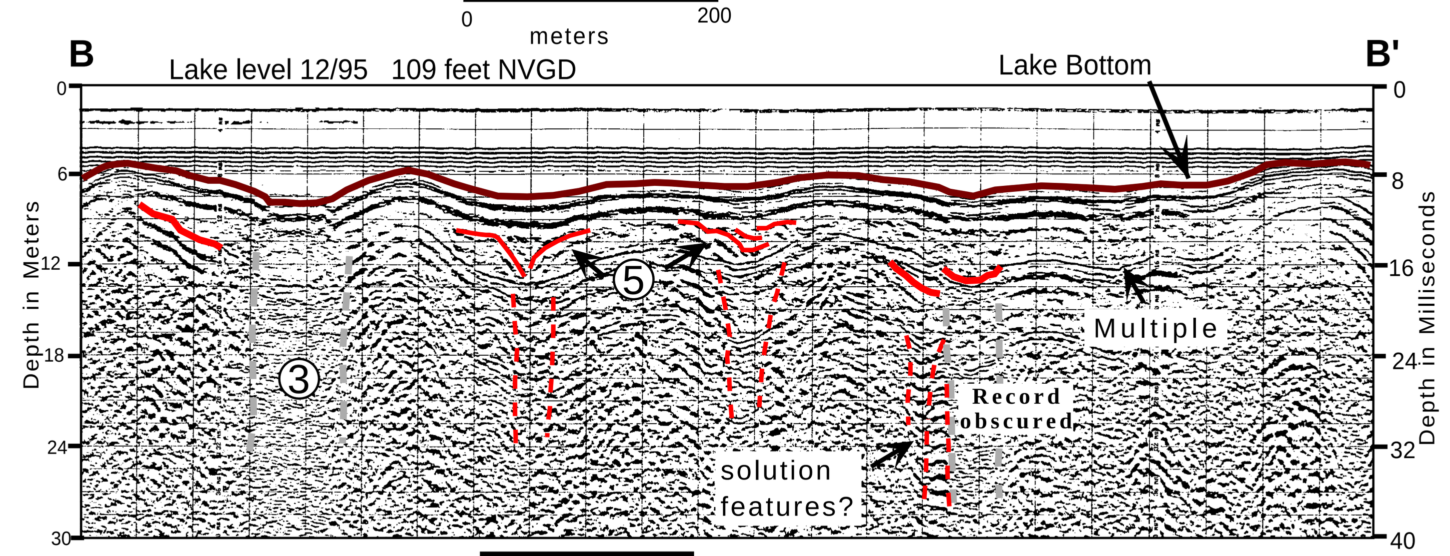


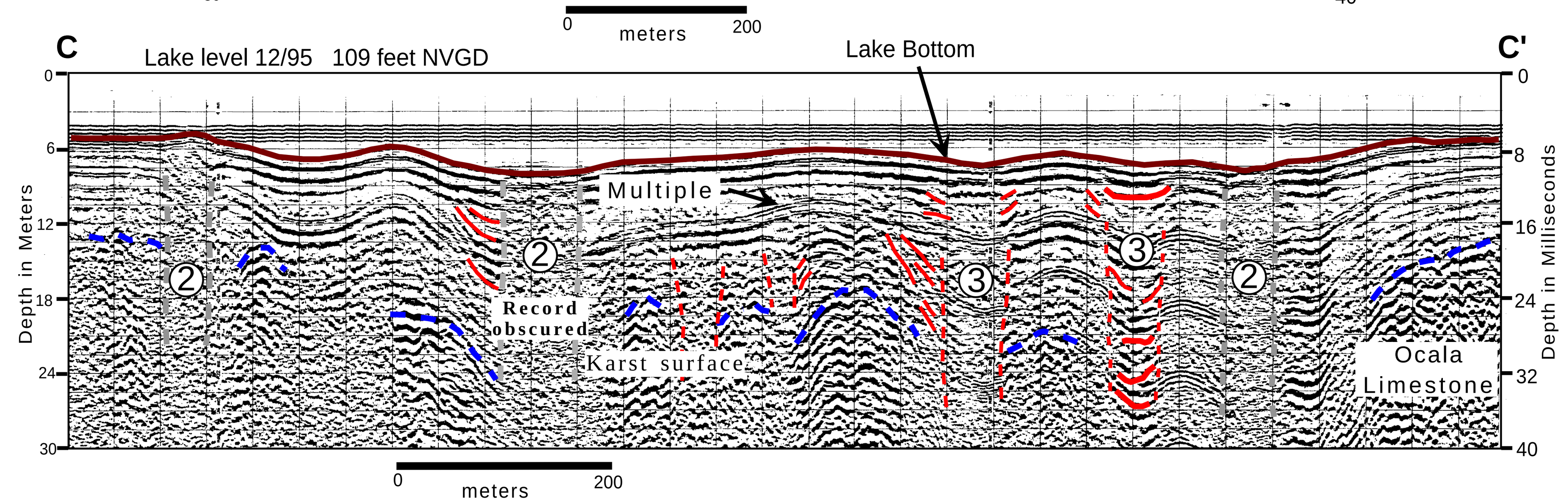
Numerous small features with high angle reflectors dipping toward their center. These features may represent localized collapse sinks or filled solution pipes.



Low- to mid-angle subsidence depressions. Parallel reflectors have undergone displacement and rotation, creating stress fractures and faulting within the depression. The subsidence may or may not be filled with overburden.







INTRODUCTION

The potential fliud exchange between lakes of northern Florida and the Floridan aquifer and the process by which exchange occurs is of critical concern to the St. Johns River Water Management District (SJRWMD). High-resolution seismic tools with relatively new digital technology were utilized in collecting geophysical data from > 40 lakes and rivers. The data collected shows the application of these techniques in understanding the formation of individual lakes and rivers, thus aiding in the management of these natural resources by identifying breaches or areas where the confining units are thin or absent between the water bodies, the Intermediate aquifer and the Floridian aquifer.

This study was a cooperative investigation conducted from 1993 to 1996 by the SJRWMD and U.S. Geological Survey Center for Coastal Geology (USGS). Since 1989 there have been technical and hardware advances in the digital acquisition of high-resolution seismic data. The primary objective of this cooperative was to test newly developed digital high-resolution single-channel marine seismic continuous-profiling-equipment (HRSP) and apply this technology to identify subbottom features that may enhance leakage from selected lakes and the St. Johns River. The target features include: (1) identifying evidence of breaches or discontinuities in the confining units between the water bodies and the aquifer, and; (2) identifying areas where the confining unit is thin or absent.

METHODS

In cooperation with SJRWMD the USGS acquired and upgraded a digital seismic acquisition system. The Elics Delph2 High-Resolution Seismic System was acquired with proprietary hardware and software running in real time on an Industrial Computer Corp. 486/33 PC. Hard-copy data was displayed on a gray scale thermal plotter. Digital data was stored on a rewritable Magneto-Optical compact disk. Navigation data was collected using a Trimble GPS or PLGR (Rockwell) GPS. GeoLink XDS mapping software was used to display navigation.

The acoustic source was the Huntec Model 4425 Seismic Source Module and a catamaran sled with an electromechanical device. Occasionally, an ORE Geopulse power supply was substituted for the Huntec Model 4425. Power was set at 60 joules or 135 joules depending upon conditions. An Innovative Transducers Inc. ST-5 multi-element hydrophone was used to detect the return acoustical pulse. This pulse was fed directly into the Elics Delph2 system for storage and processing.

Forty-four line-km of HRSP data was collected from Lake Disston. A velocity of 1500 meters per second (m/s) was used to calculate a depth scale for the seismic profiles. Measured site specific velocity data is not available for these sites.

These surveys were conducted in part to test the effectiveness of shallow-water marine geophysical techniques in the freshwater lakes of central Florida. Acquisition techniques were similar but modifications were necessary. Data quality varied from good to poor with different areas and varying conditions. As acquisition techniques improved so did data quality in general. In many areas an acoustic multiple masked much of the shallow geologic data.

Physiography

Lakes Dixie is among a cluster of small lakes in southeastern Lake County. The physiography is described by Brooks, 1981, as The Gap; an area of lower elevation, about 25 to 37m (85 to 120 ft) between the Sugarloaf Mountain region and No Name Ridge. The lower elevation is a result of increased erosion of the underlying limestone. The Gap and the flanking highlands are part of the Lake Wales Ridge, which is the topographic crest of Central Florida (Brooks, 1981). The Ridge is characterized by residual sand hills, relic beach ridges and paleo dune fields. The topography on either side of the ridge has been reduced to the water table, forming Green swamp to the southwest and Sawgrass Bays to the southeast. Lake level in December of 1995 was 26 m (85 ft) NVGD. Lake Dixie is roughly circular, with a perimeter of 4 km and a surface area of about 1 sq. km.

GEOLOGIC CHARACTERIZATION

Seismic profiles from Lake Dixie show a hard bottom reflection, possibly well sorted sands, infilling a deeper karst surface (feature 1, profile A-A'). The strong bottom reflector leads to multiples seen throughout the data that obscure some of the record. Noise below the topographic lows in the profiles also obscure some of the record (grey lines, profile B-B'). This noise could be a result of the accumulation of organic material in the depressions which attenuates the acoustic signal. The subsurface is characterized by numerous small depressions with high angle reflectors dipping toward their center (profile C-C'). The high angle reflectors may extend to depth in the profile. These features may represent solution pipes dissolved into the karst subsurface. Larger subsidence features can also be seen in the profiles (feature 9, profile A-A'). A plot of their distribution (figure 1, brown line) shows three distinct areas of subsidence and their influence on the lake's bathymetry (blue line).

A deeper, strong reflector can be seen in many of the subbottom profiles (red line, profiles A-A', B-B'). This reflector is indicative of a highly erosional (karst) surface seen in profiles throughout the region. Interpretations of a gamma log acquired from a well located approximately 1.5 km southeast of the lake (well L-0677, profile A-A', hillshade sheet #) shows the top of the Ocala Limestone to be around 50 feet NVGD. This correlates well with the horizon seen in the profiles. Differential dissolution in the Ocala Limestone could lead to subsequent subsidence in the overlying sediments of the Hawthorn Group and the undifferentiated fill.

Figure 1. Distribution of features noted from seismic profiles.